

# Nick Borcharding

## Curriculum Vita

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## Professional Experience

- 2024-Present **Assistant Professor**  
*Washington University St Louis*
- 2022-2024 **Head of Computational Biology**  
*Omniscope, Inc*
- 2022-2023 **Senior Computational Biologist**  
*Santa Ana Bio, Inc*

## Education & Training

- 2024-Present **Director in Training, American Society of Histocompatibility and Immunogenetics**  
Mentored by Chang Liu
- 2022-2023 **Postdoctoral Researcher, Department of Pathology and Immunology, Washington University**  
Co-mentored by David DeNardo and Jon Brestoff
- 2020-2023 **Clinical Pathology Resident, Department of Pathology and Immunology, Washington University**
- 2014-2020 **MD, University of Iowa Carver College of Medicine**
- 2014-2020 **PhD, University of Iowa Carver College of Medicine**  
Cancer Biology Graduate Program  
Mentored by Weizhou Zhang
- 2012-2014 **MS, University of Iowa Carver College of Medicine**  
Pathology Graduate Program
- 2009-2012 **BS, Iowa State University, summa cum laude**  
Nutritional Sciences

## Publications

- [1] Corvino, D., Batstone, M., Hughes, B., Kempchen, T., Ng, S., Salim, N., Schneppenheim, F., Rommel, D., Kumar, A., Pearson, S., Madore, J., Koufariotis, L., Steinheuer, L., Pathirana, D., Thurley, K., Hasenauer, J., Holzel, M., **Borcharding, N.**, Engwerda, C., Braun, M., & Bald, T. (2024). Type I interferon drives a cellular state inert to TCR-stimulation and possibly impedes effective T-cell differentiation in cancer. *European Journal of Immunology*. In Press.

- [2] **Borcherding, N.**, Quinn, M., Han, F., Kim, W., Zhou, J.Q., Sturtz, A., Schmitz, A., Lei, T., Schattgen, S., Haile, A., Klebert, M., Suessen, T., Middleton, W., Goss, C., Liu, C., Crawford, J.C., Teehey, S., Presti, R.M., O'Halloran, J.A., Thomas, P.G., Turner, J.A., Ellebedy, A. & Mudd, P.A. (2024). Human antigen-specific CD4<sup>+</sup> T cells exhibit distinct phenotypes in the lymph node and blood following vaccination or infection. *Nature Immunology*. In Press.
- [3] Kim, M., De, U., **Borcherding, N.**, Wang, L., Paek, J., Bhattacharyya, I., Yu, Q., Kolb, R., Drashansky, T., Thatayatikom, A., Zhang, W., & Cha, S. (2024). Single-cell transcriptomics unveil profiles and interplay of immune subsets in rare autoimmune childhood Sjorgen's disease. *Communications Biology*. PMID: 38641668.
- [4] Irac, S., Soon, M., **Borcherding, N.**, & Tuong, Z.K. (2024) Single-cell immune repertoire analysis. *Nature Methods*. PMID: 38637691.
- [5] Pothuri, V., Hogg, G., Conant, L., **Borcherding, N.**, James, C.A., Mudd, J., Williams, G., Seo, Y., Hawkins, W.G., Pillarisetty, V., DeNardo, D., & Fields, R.C. (2024). Intratumor T-cell Receptor Repertoire Composition Predicts Overall Survival in Patients with Pancreatic Ductal Adenocarcinoma. *OncImmunity*. PMID: 38504847.
- [6] Mazziotta, F., Biavati, L., Rimando, J., **Borcherding, N.**, Parbhoo, S., Mukhopadhyay, R., Knaus, H., Borrello, I., Rutella, S., Blazar, B., Gojo, I. & Luznik, L. (2023). An unbalanced proportion between stem-like and senescent-like bone marrow CD8<sup>+</sup> T cells predict detrimental outcomes in Acute Myeloid Leukemia. *Blood*. In Press.
- [7] **Borcherding, N.** & Brestoff, J. (2023). The Power and Potential of Mitochondria Transfer. *Nature*. PMID: 3798702.
- [8] Andreatta, M., Gueguen, P., **Borcherding, N.**, & Carmona S. (2023). T cell clonal analysis using single-cell RNA sequencing and reference maps. *BioProtocols*. PMID: 37638293.
- [9] Lefebvre, M., **Borcherding, N.**, Reis, R., Mou, E., Liu, V., and Jabbari, A. (2023). Molecular techniques drive cutting edge advancements in the management of cutaneous T cell lymphoma. *Frontiers in Immunology*. PMID: 37654486.
- [10] Westerhof, L.M., Noonan, J., Hargrave, K., Chimbayo, E.T., Chen, Z., Purnell, T., **Borcherding, N.**, & MacLeod, M. (2023) Enhanced survival and low proliferation marks multifunctional virus specific memory CD4 T cells. *European Journal of Immunology*. PMID 37490492.
- [11] Baer, J.M., Zuo, C., Kang, L., Lastra, A., **Borcherding, N.**, Knollhoff, B.L., Bogner, S., Zhu, Y., Lewis, M., Zhang, N., Kim, K., Fields, R.C., Yokoyama, W., Mills, J.C., Ding, L., Randolph, G.J., & DeNardo, D. (2023). Fibrosis induced by resident macrophages has divergent roles in pancreas inflammatory injury and PDAC. *Nature Immunology*. PMID: 37563309.
- [12] Crawford, M., **Borcherding, N.**, & Karandikar, N. (2023). IL-17 cytokines preferentially act on naïve CD4<sup>+</sup> T cells with the IL-17AF heterodimer inducing the greatest functional changes. *PLoS ONE*. PMID: 37115755.
- [13] Herzog, B., Baer, J., **Borcherding, N.**, Kingston, N., Belle, J.I., Knollhoff, B., Hogg, G., Faiz, A., Kang, L., Lin, C., Govindan, R., & DeNardo, D. (2023). Tumor associated fibrosis impairs immune surveillance and response to immunotherapy in NSCLC. *Science Translational Medicine*. PMID: 33861994.
- [14] Liu, X., Hogg, G.D., Zuo, C., Baer, J.M., Lander, V., Kang, L., **Borcherding, N.**, Knollhoff, B.L., Osterhout, R., Glakin, A.V., Bruey, J.M., Varter, L.L., Mpoy, C., Schwarz, J.K., Park, H., Gupta, V., & DeNardo, D. (2022) Context-dependent triggering of STING-interferon signaling by CD11b agonist supports anti-tumor immunity in mouse and human cancer patients. *Cancer Cell*. PMID: 37236195.
- [15] He, M., Roussak, K., Ma, F., **Borcherding, N.**, Garin, V., White, M., Schutt, C., Jensen, T.I., Zhao, Y., Iberg, C., Shah, K., Bhatia, H., Korenfeld, D., Dinkel, S., Gray, J., Ulezko, A., Ferris,

- S., Donoermeyer, D., Arlehamn, C., Gubin, M.M., Luo, J., Gorvel, L., Pellegrini, M., Sette, A., Tung, T., Bak, R. Modlin, R., Fields, R.C., Shreiber, R.D., Allen, P.M., & Klechevsky, E. (2022). CD5 expression by dendritic cells directs T cell immunity and sustains immunotherapy response. *Science*. PMID: 36795805.
- [16] Shrode, R.L, Cady, N., Jensen, S., **Borcherding, N.**, & Mangalam, A.K. (2022). Isoflavone consumption reduces inflammation through modulation of phenylalanine and lipid metabolism. *Metabolomics*. PMID: 36289122.
- [17] Rauckhorst, A.J., **Borcherding, N.**, Pape, D., Kraus, A.S., Scerbo, D., & Taylor, E.B. (2022) The mouse tissue metabolome rapidly degrades after terminal loss of perfusion. *Molecular Metabolism*. PMID: 36100179.
- [18] Dong, Q., Xiu, Y., Wang, Y., Hodgson, C., **Borcherding, N.**, Jordan, C., Buchanan, J., Taylor, E., Wagner, B., Leidinger, M., Holman, C., Thiele, D., O'Brien, S., Xue, H., Zhao, J., Li, Q., Meyerson, H., Boyce, B., & Zhao, C. (2022). HSF1 is a driver of leukemia stem cell self-renewal in acute myeloid leukemia. *Nature Communications*. PMID: 36245043.
- [19] Lander, V.E, Belle, J, Kingston, N, Herndon, J., Hogg, G., Liu, X., Kang, L., Knolhoff, B., Bogneg, S., Baer, J., Zuo, C., **Borcherding, N.**, Lander, D.P., Mpoy, C. , Scott, J., Zahner, M., Rogers, B., Schwarz, J.K., Kim, H., & DeNardo, D. (2022) Stromal reprogramming by FAK inhibition overcomes radiation resistance to allow for immune priming and response to checkpoint blockade. *Cancer Discovery*. PMID: 36165893.
- [20] **Borcherding, N.\***, Jia, W.\*, Giwa, R., Field, R.L., Moley, J.R., Kopecky, B., Chan M., Yang, B., Sabio, J., Walker E., Osorio, O., Bredemeyer, A., Pietka, T., Alexander-Brett, J., Morley S.C., Artyomov, M., Abumrad, N., Schilling, J., Lavine, K., Crewe, C., & Brestoff, J.R. (2022) Dietary lipids inhibit mitochondria transfer to macrophages to divert adipocyte-derived mitochondria into the blood. *Cell Metabolism*. PMID: 36070756. \*co-primary authors
- [21] Alam, J., Yazdanpanah, G., Ratnapriya, R., **Borcherding, N.**, de Paiva, C., Li, D., de Souza, R., Yu, Z., & Pflugfelder, S (2022). Single cell transcriptional profiling of murine conjunctival cells reveals distinct populations of homeostatic and regulatory genes. *Mucosal Immunity*. PMID: 35361907.
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- [23] Rosina, M., Ceci, V., Turchi, R., Chuan, L., **Borcherding, N.**, Sciarretta, F., Sánchez-Díaz, M., Tortolici, F., Karlinsey, K., Chiurciu, V., Fuoco, C., Giwa, R., Audano, M., Sciarretta, F., Arena, S., Palma, A., Riccio, F., Shamsi, F., Renzone, G., Verri, M., Crescenzi, A., Rizza, S., Faienza, F., Filomeni, G., Kooijman, S., Rufini, S., de Vries, A., Scalon, A., Mitro, N., Tseng, Y., Hidalgo, A., Zhou, B., Brestoff, J. Aquilano, K., Lettieri-Barbato, D. (2022). Brown Adipocytes Transfer Damaged Mitochondrial Fragments to Macrophages to Avoid the Failure of Thermogenic Program. *Cell Metabolism*. PMID: 35305295.
- [24] Alam, J., Yazdanpanah, G., Ratnapriya, R., **Borcherding, N.**, de Paiva, C., Li, D., de Souza, R., Yu, Z., & Pflugfelder, S. (2022). IL-17 Producing Lymphocytes Cause Dry Eye and Corneal Disease With Aging in RXRa Mutant Mice. *Frontiers in Medicine*. PMID: 35402439.
- [25] Lasrado, N., **Borcherding, N.**, Arumugam, R., Starr, T.K., & Reddy, J. (2022). Dissecting the transcriptome Network and Cellular Heterogeneity in Viral Myocarditis by Single-Cell RNA Sequencing. *iScience*. PMID: 35243228.
- [26] Maharjan, C.K., Mo, J., Wang, L., Kim, M., **Borcherding, N.**, Vikas, P., & Zhang, W. (2022). Natural and Synthetic Estrogens in Chronic Inflammation and Breast Cancer. *Cancers*. PMID: 35008370.

- [27] Kim, M., Jin, Z., **Borcherding, N.**, Kolb, R., & Zhang, W. (2021). Updates on Immunotherapy and Immune Landscape in clear renal cell carcinoma. *Cancers*. PMID: 34831009.
- [28] Zhao, J. Xiu, Y., Fu, L., Dong, Q., **Borcherding, N.**, Wang, Y., Li, Q., Boyce, B., Klein, U., & Zhao, C. (2021). TIFAB Accelerates MLL-AF9-Induced Acute Myeloid Leukemia Through Upregulation of HOXA9. *iScience*. PMID: 34877491.
- [29] Fujiwara, Y., Torphy, R.J., Sun, Y., Miller, E.N., Ho, F., **Borcherding, N.**, Wu, T., Torres, R., Zhang, W., Schulick, R.D., & Zhu, Y. (2020). The BigLen/GPR171 pathway suppresses T cell activation and limits antitumor immunity. *Nature Communications*. PMID: 3415877.
- [30] Subramani, S., Bellizzi, A., **Borcherding, N.**, Kao, S., Dillon, J., Howe, J., Norris, A.N., Tansey, M., & Pinnaro, C. (2021) Hypoglycemia secondary to insulinoma masking the onset of type 1 diabetes in an adolescent. *Clinical Case Reports*. PMID: 34594558.
- [31] Kim, M.\*, **Borcherding, N.\***, Ahmed, K.A.\*, Voigt, A.P., Vishwakarma, V., Kolb, R., Kluz, P., Pandey, G., De, U., Drashansky, T., Helm, E.Y., Zhang, X., Gibson-Corley, K.N., Klesney-Tait, J., Zhu, Y., Lu, J., Lu, J., Huang, X., Xiang, H., Cheng, J., Wang, D., Wang, Z., Tang, J., Hu, J., Wang, Z., Liu, H., Li, M., Zhuang, H., Avram, D., Zhou, D., Bacher, R., Zheng, S., Wu, X., Zakharia, Y., Weizhou Zhang, W. (2021). CD177 modulates the function and homeostasis of tumor-infiltrating regulatory T cells. *Nature Communications*. PMID: 34599187. \*co-primary authors
- [32] Reynolds, D., Vazquez Guillamet, C., Day, A., **Borcherding, N.**, Vazquez Guillamet, R., Chorenó-Parra, J.A., House, S.L., O'Halloran, J.A., Zuniga, J., Ellebedy, A.H., Byers, D.E., Mudd, P.A. (2021) Comprehensive immunologic evaluation of bronchoalveolar lavage samples from human patients with moderate and severe influenza and severe COVID-19. *Journal of Immunology*. PMID: 34348975
- [33] Amanat, F., Thapa, M., Lei, T., Sayed, Ahmed, S.M., Adelsberg, D., Cerreno, J.M., Strohmeier, S., Schmitz, A.J., Zafar, S., Zhou, J.Q., Rejnink, W., Alshammary, H. **Borcherding, N.**, Reiche, A.G., Strivastava, K., Sordillo, E., van Bakel, H., The Personalized Virology Initiative, Bajic, G., Simon, V., Ellebedy, A.H., & Krammer, F. (2021). SARS-CoV-2 mRNA vaccination induces functionally diverse antibodies to NTD, RBD, and S2. *Cell*. PMID: 34192529.
- [34] **Borcherding, N.** & Gronowski, A. Commentary on a case of Unexpected Hyperglycemia. (2021). *Clinical Chemistry*. PMID: 34352082.
- [35] Merritt, N., Garcia, K. Rajendran, D., Lin, Z.Y., Zhang, X., Mitchell, K., **Borcherding, N.**, Fullenkamp, C., Chimenti, M., Gingras, A.C., Harvey, K., & Tanas, M. (2021) TAZ-CAMTA1 and YAP3-TFE3 alter TAZ/YAP transcriptome by recruiting the ATAC histone acetyltransferase complex. *eLife*. PMID: 33913810.
- [36] Mathew, N.R., Jayanthan, J.K., Smirnov, I., Robinson, J.L. Axelsson, H., Nakka, S.S., Emmanouilidi, A., Czarnewski, P., Yewdell, W.T., Lebrerio-Fernandez, C, Bernasconi, V., Rodin, W., Harandi, A.M, Lycke, N., **Borcherding, N.**, Yewdell, J.W., Greiff, V., Bemark, M., & Angeletti, D., (2021) Single-cell BCR and transcriptome analysis influenza infection reveals spatiotemporal dynamics of antigen-specific B cell response. *Cell Reports*. PMID: 34161770.
- [37] Kolb, R., De, U., Khan, S., Luo, Y., Kim, M., Yu, H., Wu, C., Zhang, X., Zhang, X., **Borcherding, N.**, Zheng, G., Zhou, D., & Zhang, W. (2021). Proteolysis-targeting chimera against BCL-XL destroys tumor-infiltrating regulatory T cells. *Nature Communications*. PMID 33627663.
- [38] **Borcherding, N.\***, Vishwakarma, A.\*, Voigt, A.P., Nepple, K., Salem, A., Jenkins, R.W., Zhang, W., Zakharia, Y. (2021) Mapping the immune environment in clear cell renal carcinoma by single-cell genomics. *Communications Biology*. PMID: 33504936. \*co-primary authors

- [39] Cheng, Y., **Borcherding, N.**, Ogunsakin, A., Lemke-Miller, C.D., Gibson-Corley, K.N., Rajan, A., Wongpattaraworakul, W., Chan, C.H., Salem, A.K., Weiner, G.J., Simons, A.L. (2021). The anti-tumor effects of cetuximab in combination with motolimod are T cell dependent. *Scientific Reports*. PMID: 33452311.
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- [41] Swami, U., Chennamadhavuni, A., **Borcherding, N.**, Bossler, A.D., Mott, S.L., Garje, R., Zakharia, Y., & Milhem, M.M. (2020). Multivariate analysis of 169 cases of advanced cutaneous melanoma to evaluate antibiotic exposure as a predictor of survival to anti-PD-1 based immunotherapies. *Antibiotics*. PMID: 33120998.
- [42] **Borcherding, N.**, Jethava, Y., Vikas, P. (2020). Repurposing anti-cancer drugs for COVID-19. *Drug Design, Development and Therapy*. PMID 33239864.
- [43] Renavikar, P.S., Sinha, S., Brate, A.A., **Borcherding, N.**, Crawford, M.P., Steward-Tharp, S., & Karandikar, N. (2020). IL-12-Induced Immune Suppressive Deficit During CD8+ Differentiation. *Frontiers in Immunology*. PMID: 33193343.
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- [47] Kluz, P.N., Kolb, R., Xie, Q., **Borcherding, N.**, Liu, Q., Wang, L., Zhang, Y., Li, W., Stipp, C., Gibson-Corley, K.N., Zhao, C., Qi, H.H., Bellizzi, A., Tao, A.W., Sugg, S., Weigel, R.J., Shen, X., Zhang, W. (2020). Cancer cell-intrinsic function of CD177 in attenuating  $\beta$ -Catenin signaling. *Oncogene*. PMID: 32042113.
- [48] **Borcherding, N.\*** Bormann, N., & Kraus, G. (2020). scRepertoire: A R-based toolkit for single-cell immune receptor analysis. *F1000Research*. PMID: 32789006. \*corresponding author
- [49] Liu, Q., **Borcherding, N.**, Shao, P., Maina, P., Zhang, W., & Qi, H. (2019). Contribution of synergism between PHF8 and HER2 signaling to breast cancer development and drug resistance. *EBioMedicine*. PMID: 31923801.
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- [51] Wu, V., Kiriazov, B., Koch, K., Gu, V., Beck A., **Borcherding, N.**, Li, T., Addo, P., Wehrspan, Z., Zhang, W., Braun, T., Brown, B., Band, V., Band, B., Kulak, M., & Weigel, R. (2020). A TFAP2C Gene Signature is Predictive of Outcome in HER2-positive Breast Cancer. *Molecular Cancer Research*. PMID: 31619506.
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- [53] Liu, Q.\*, **Borcherding, N.\***, Shao, P., Cao, H., Zhang, W., & Qi, H. (2019). Identification of novel TGF- $\beta$  regulated genes with pro-migratory roles. *Molecular Basis of Disease*. [PMID: 31449970](#). \*co-primary authors
- [54] Pandey, G.\*, **Borcherding, N.\***, Kolb, R., Kluz, P., Li, W., Sugg, S., Zhang, J., Lai, D., & Zhang W. (2019). ROR1 potentiates FGFR signaling in basal-like breast cancer. *Cancers*. [PMID: 31137681](#). \*co-primary authors
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- [63] Liu, Q., Kulak, M., **Borcherding, N.**, Maina, P., Zhang, W., Weigel, R., & Qi, H. (2017). A novel *HER2* gene-body enhancer contributes to *HER2* expression. *Oncogene*. [PMID: 29035388](#).
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- [71] Mahauad-Fernandez, W.D.\*, **Borcherding, N. C.\***, Zhang, W., & Okeoma, C.M. (2015). Bone Marrow Stromal Antigen 2 (BST-2) DNA Is Demethylated in Breast Tumors and Breast Cancer Cells. *PLoS One*. PMID: 25393878. \*co-primary authors
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- [73] Xie, Q., Klesney-Tait, J., Keck, K., Parlet, C., **Borcherding, N.**, Kolb, R., Li, W., Tygrett, L., Waldschmidt, T., Olivier, A., Chen, S., Liu, G. H., Li, X., & Zhang, W. (2015). Characterization of a novel mouse model with genetic deletion of CD177. *Protein & Cell*. PMID: 25359465
- [74] **Borcherding, N.**, Kusner, D., Liu, G. H., & Zhang, W. (2014). ROR1, an embryonic protein with an emerging role in cancer biology. *Protein Cell*. PMID: 24752542.
- [75] Wu, X., Zhang, W., Font-Burgada, J., Palmer, T., Hamil, A. S., Biswas, S. K., Poidinger, M., **Borcherding, N.**, Xie, Q., Ellies, L. G., Ltyle, N. K., Wu, L. W., Fox, R. G., Yang, J., Dowdy, S. F., Reya, T., & Karin, M. (2014). Ubiquitin-conjugating enzyme Ubc13 controls breast cancer metastasis through a TAK1-p38 MAP kinase cascade. *Proceedings of the National Academy of Science*. PMID: 25189770.
- [76] Smazal, A. L.\*, **Borcherding, N. C.\***, Anderegg, A. S., Schalinske, K. L., Whitley, E. M., & Rowling, M. J. (2013). Dietary resistant starch prevents urinary excretion of 25-hydroxycholecalciferol and vitamin D-binding protein in type 1 diabetic rats. *Journal of Nutrition*. PMID: 23677864. \*co-primary authors
- [77] Zhang, W., Tan, W., Wu, X., Poustovoitov, M., Strasner, A., Li, W., **Borcherding, N.**, Ghassemian, M., & Karin, M. (2013). A NIK-IKK $\alpha$  module expands ErbB2-induced tumor-initiating cells by stimulating nuclear export of p27/Kip1. *Cancer Cell*. PMID: 23602409.

## Textbooks or Chapters

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- [1] Kolb, R., **Borcherding, N.**, & Zhang, W. (2020). Understanding and targeting human cancer regulatory T cells to improve cancer therapy. T Regulatory Cells in Health and Disease. London, UK: *Springer Nature*. ISBN 978-981-15-6407-9
- [2] Zhang, W., **Borcherding, N.**, Kolb, R. (2019) IL-1 signaling in the tumor microenvironment. Tumor Microenvironment. New York City, NY: Springer International Publishing. ISBN: 978-3-030-34025-4.
- [3] Schalinske, K., **Borcherding, N.** Rowling, M. (2016). Advanced Nutrition and the Regulation of Metabolism. San Diego, CA: *Cognella Academic Publishing*. ISBN: 978-1-5165-1468-7

## Software

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**immApex** <https://github.com/ncborcherding/immApex>  
**ClamBake** Licensed to Columbus Instruments  
**Ibex** <https://github.com/ncborcherding/Ibex>  
**Trex** <https://github.com/ncborcherding/Trex>  
**Escape** <https://www.bioconductor.org/packages/release/bioc/html/escape.html>  
**scRepertoire** <https://www.bioconductor.org/packages/release/bioc/html/scRepertoire.html>  
**TRGAted** <https://ncborcherding.shinyapps.io/TRGAted/>

## Submitted Manuscripts

- [1] Dorando, H., Andrews, J., **Borcherding, N.**, Quinn, C., Schmidt, J., Khatavkar, O., Aluri, J., Cooper, M., Musiek, A., Mehta-Shah, N., & Payton, J. (2024). Single Cell Resolution Tracking of Cutaneous T Cell Lymphoma Reveals Clonal Evolution in Disease Progression.
- [2] Noonan, J., **Borcherding, N.**, Gherardin, N., Domke, L., Watson, A., Huang, A., Barbaro-Wahl, A., Prijaya, S., Michla, M., Huang, Y., Dayawansa, N., Bongcaron, V., Walsh, A., Sharma, P., Maluenda, A., Kannelakis, P., Farrugia, G., Lee, M., Murphy, A., Hsu, I., Pinto, A., Johnson, C., Chih-Chen, Y., Eddy, E., Lovelock, T., Wang, J., Bourke, M., Rahman, Z., Varley, V., Kilby, J., Giacca, M., Zentilin, L., McFadyen, J., Wang, X., Martelotto, L., Hill, D., Godfrey, D., Uldrich, A., Bobik<sup>1</sup>, A., Benson, R., Otto, T., MacLeod, M., Vasudevan, T., Axel Kallies, A., & Peter, K. (2024). TCR dependent CD8+ T cell responses drive atherogenesis and atherosclerotic plaque stability.
- [3] MacGivney, G., Brockman, Q., **Borcherding, N.**, Scherer, A., Rauckhorst, A., Gutierrez, W., Solst, S., Heer, C., Warriar, A., Floyd, W., Kirsch, W., Knepper-Adrian, V., Lavery, E., Roughton, G., Spitz, D., Taylor, E., & Dodd, R. (2024). Multiomic analysis reveals molecular subtypes that extend to phenotype metabolic vulnerability in a rare sarcoma.
- [4] Angelats, L., Pare, L., Rubio-Perez, C., Sanfeliu, E., Gonzalez, A., Segui, E., Villacampa, G., Marin-Aguilera, M., Pernas, S., Conte, B., Martinez-Saez, O., Aguirre, A., Galvan, P., Fernandez-Martinez, A., Cobo, S., Rey, M., Walbaum, Schettini, F., Vidal, M., Buckingham, W., Munoz, M., Adamo, B., Guedan, Sonia, Pascual, T., Agudo, J., Grzelak, M., **Borcherding, N.**, Heyn, H., Vivancos, A., Parker, J., Villagrasa, P., Perou, C., Prat, A., & Braso-Maristany, F., (2024). Immune Infiltration Predicts Longevity in Breast Cancer Survivors Without Recurrence.
- [5] Nakai, R., Varnum, S., Field, R., Shi, H., Giwa, R., Jia, W., Krysa, S., Cohen, E., **Borcherding, N.**, Saneto, R., Tsai, R., Suganuma, M., Ohta, H., Yokota, T., & Brestoff, J. (2024). Mitochondria transfer-based therapies reduce the morbidity and mortality of Leigh Syndrome.
- [6] Wang, L, Marharjan, C., **Borcherding, N.**, Master, R., Mo, J., Tithi, T.I., Kim, M., Carelock, M., Master, A.P., Gibson-Corley, K., Kolb, R., Smith, K.A., Zhang, W. (2024). Epithelial IL-2 is critical for NK cell-mediated cancer immunosurveillance in mammary glands.
- [7] Moley, J., Wright, J., Jia, W., Field, R., Lewis, A., Giwa, R., Varnum, S., Zhang, X., Rowen, M., Krysa, S., Infante, R., **Borcherding, N.**, Gelman, A., & Brestoff, J. (2023). Rubicon restrains mitophagy to curtail obesity.
- [8] Mo, J, **Borcherding, N.**, Jo, S., Tithi, T., Cho, E., Ahmed, K., Kolb, R., Weigel, R., Spies, M., & Zhang, W. (2023). Contrasting roles of different mismatch repair proteins in basal-like breast cancer.
- [9] Kim, M., De, U., **Borcherding, N.**, Paek, J., Winn, N., Bhattacharyya, I, Yu, Q., Kolb, R., Drashansky, T., Thatayatikom, A., Zhang, W., & Cha, S. (2023) A single-cell atlas of childhood Sjorgen's disease.



- [10] **Borcherding, N.**, Sun, B., DeNardo, D., & Brestoff, J. (2032). Ibex: Variational autoencoder for single-cell BCR sequencing.
- [11] Shahi, S., Ghmire, S., Jensen, S.N., Lehman, P., **Borcherding, N.**, Gibson-Corley, K., Ganesan, S.M., Karndikar, N., & Mangalam, A.K. (2023). IL-17A controls CNS autoimmunity by regulating gut microbiota and inducing regulatory T cells.

## Research Funding

<b>2022-2023</b>	<b>Interdivision Translational Research Department of Pathology</b> Measuring intercellular mitochondria transfer with single-cell sequencing Role: Co-Investigator
<b>2017-2020</b>	<b>NIH F30 CA206255</b> Paracrine non-canonical Wnt signaling in breast cancer Role: PI
<b>2017</b>	<b>Oberley Seed Grant for Experiment Therapeutics</b> Targeting mismatch repair for immunotherapy in basal-like breast cancer Role: Co-PI
<b>2015-2016</b>	<b>American Medical Association Foundation Research Seed Grant</b> Paracrine non-canonical Wnt signaling in breast cancer Role: PI

## Invited Presentations

- [1] **Borcherding, N.**, Single-cell characterization of the T follicular immune response in COVID-19 vaccination using deep learning (2023, June). Presented at Physician-Scientist Symposium in St Louis, MO.
- [2] **Borcherding, N.**, Single-cell characterization of the T follicular immune response in COVID-19 vaccination using deep learning (2023, January). Presented at the Single Cell Club Montreal meeting.
- [3] **Borcherding, N.**, Crotts, S., Ortolan, L., Bormann, N., & Jabbari, A. (2020, May). Single-cell mRNA sequencing of murine and human alopecia areata identifies immune cell profiles predictive of human disease state. Presented at the Academy of Clinical Laboratory Physicians and Scientists Annual Meeting in Iowa City, IA.
- [4] **Borcherding, N.**, Voigt, A., Liu, V., Link, B.K., Zhang, W., & Jabbari, A. (2019, May) Single-cell profiling of cutaneous T-cell lymphoma reveals underlying heterogeneity associated with disease progression. Presented at the Society for Investigative Dermatology Annual Meeting in Chicago, Illinois.
- [5] **Borcherding, N.**, Transcriptional Heterogeneity in cancer-associated regulatory T cells is predictive of survival. Presented at the Single-Cell RNA sequencing Symposium by the Iowa Institute of Genetics, Iowa City, Iowa.
- [6] **Borcherding, N.** Paracrine Regulation of Breast Cancer Tumorigenesis. (2016, April). Presented at the Midwestern Association of Graduate Schools Conference in Chicago, IL.

## Conference Abstracts

- [1] Heyn, H., Melero, J., Deuner, G., Baraibar, I., Grzelak, M., Caratú, G., García-Durán, C., Grau, F., García-Illescas, D., Fariñas, L., Paula Nieto, P., Morabito, S., Rotem, A., Casbas-Hernandez,

- P., Gros, A., Tabernero, J., Oaknin, A., Nieto, J., **Borcherding, N.**, & Élez, E. Liquid biopsy tracking of immunotherapy-induced T cell dynamics in MSS colorectal and endometrial tumors (2024, September). Presented at the ESMO Congress Annual Meeting.
- [2] Melero, J., Sentís, I., Cebria-Xart, A., Caratu, G., Grzelak, M., Soto, M., Rodríguez-Hernández, C., Mendizabal-Sasieta, A., Maspero, D., Pascual, A., Perez, J., Galan, R., Borcherding, N., Nieto, J., Avgustinova, A., & Heyn, H. Spatio-temporal tracking of therapy-induced T cell immunity against pediatric rhabdoid tumors. (2024, May). Presented at the Innovations in Single Cell Omics.
- [3] Melero, J., Grzelak, M., Pravdyvets, D., Soto, M., Mendizabal-Sasieta, A., Perron, U., **Borcherding, N.**, & Heyn, H. Ultra deep single-cell T cell receptor sequencing for cancer therapeutics and prognosis. (2024, April). Presented at LSX World Congress Annual Meeting.
- [4] Melero, J., Colom-Sanmartí, B., Mendizabal-Sasieta, A., Perron, U., Grzelak, M., Pravdyvets, D., Soto, M., Nieto, J., Vidal, S., Tejpar, S., **Borcherding, N.**, Planas-Rigol, E., & Heyn, H. Integrated modeling of T cell repertoires to identify clonotype signatures of ICI response (2024, April). Presented at the Immuno-Oncology Summit Europe.
- [5] Planas-Rigol, E., Melero, J., Colom-Sanmartí, B., Bonfill-Teixidor, E., Arias, A., Grzelak, M., Pravdyvets, D., Sant, M., Martelotto, L., **Borcherding, N.**, Heyn, H., Seoane, J. Quantification of Brain Metastasis-Infiltrating T cells in Blood Using Ultra-Deep Single-Cell T Cell Repertoire Sequencing (2024, April). Presented at the American Association of Cancer Research Annual Meeting.
- [6] Melero, J., Colom-Sanmartí, B., Mendizabal-Sasieta, A., Perron, U., Grzelak, M., Pravdyvets, D., Soto, M., Nieto, J., Vidal, S., Tejpar, S., **Borcherding, N.**, Planas-Rigol, E., & Heyn, H. Integrated modeling of T cell repertoires to identify clonotype signatures of ICI response. (2023, December). Presented at the ESMO Immuno-Oncology Congress.
- [7] **Borcherding, N.\***, Jia, W.\*, Giwa, R., Field, R.L., Moley, J.R., Kopecky, B., Chan M., Yang, B., Sabio, J., Walker E., Osorio, O., Bredemeyer, A., Pietka, T., Alexander-Brett, J., Morley S.C., Artyomov, M., Abumrad, N., Schilling, J., Lavine, K., Crewe, C., & Brestoff, J.R. Dietary lipids inhibit mitochondria transfer to macrophages to divert adipocyte-derived mitochondria into the blood. (2023, April). Presented at the American Society for Clinical Investigation Annual Meeting.
- [8] Lasrado, N, **Borcherding, N.**, Arugmugam, R., Starr, T.K., & Reddy, J. Dissecting the complexity of heart infiltrates in post-infectious myocarditis induced with CVB3 infection by single-cell RNA sequencing analysis. (2021, May). Presented at the American Association of Immunologist Annual Meeting.
- [9] **Borcherding, N.**, Henderson, N., Ortolan, L., Liu, V., Link, B.K., Mangold, A., Jabbari, A. Comprehensive transcriptional and clonotypic analysis of peripheral blood in Sezary syndrome reveals novel expression markers and shifting gene profiles associated with treatment. (2021, May). Presented at the Society for Investigative Dermatology Annual Meeting.
- [10] **Borcherding, N.**, Henderson, N., Ortolan, L., Liu, V., Link, B.K., Mangold, A., Jabbari, A. Comprehensive transcriptional and clonotypic analysis of peripheral blood in Sezary syndrome reveals novel expression markers and shifting gene profiles associated with treatment. (2021, March). Presented at the United States and Canada Association of Pathology Annual Meeting.
- [11] **Borcherding, N.** Combining single-cell and AIRR data (2020, December). Presented at the Adaptive Immune Receptor Repertoire Society Annual Meeting.

- [12] Rauckhorst, A.J., **Borcherding, N.**, Kraus, A.S., Scerbo, D., & Taylor, E.B. (2020, September). Preserving the in vivo metabolome and energy-sensitive phosphoproteome requires rapid freezing of tissue samples. Presented at the Metabolomics Association of Northern America Annual Meeting.
- [13] **Borcherding, N.**, Crotts, S., Ortolan, L., Bormann, N., & Jabbari, A. (2020, May). Single-cell mRNA sequencing of murine and human alopecia areata identifies immune cell profiles predictive of human disease state. Presented at the Academy of Clinical Laboratory Physicians and Scientists Annual Meeting in Iowa City, IA.
- [14] Renavikar, P., Sinha, S., Brate, A., Crawford, M., **Borcherding, N.**, Steward, S. & Karandikar, N. (2020, May). Immune suppressive deficit in human Tc1 cells secondary to IL-12-induced pathways. Presented at the Academy of Clinical Laboratory Physicians and Scientists Annual Meeting in Iowa City, IA.
- [15] Hoffmann, D., Feagle, T., & **Borcherding, N.** (2020, April). Virtual Anatomy Videos for Pre-Lab Preparation: Does Usage Correlate with Grade Outcomes. Accepted to Experimental Biology Annual Meeting in San Diego, CA. (Canceled due to COVID-19).
- [16] Cole, K., Councilman, K., Zhang, W., & **Borcherding N.** (2020, March). WNT/ $\beta$ -Catenin Signaling Correlates with Improved Survival in Luminal A Breast Cancer. Presented at the USCAP Annual Meeting in Los Angeles, CA.
- [17] Vishwakarma, A., **Borcherding, N.**, Chementi, M., Vishwakarma, P., Nepple, K., Salem, A., Jenkins, R.W., Zhang, W., Zakharia, Y (2019, November). Mapping immune landscape in clear cell renal carcinoma by single-cell genomics. Presented at the AACR Special Conference on Tumor Immunology and Immunotherapy in Boston, MA.
- [18] **Borcherding, N.**, Voigt, A., Liu, V., Link, B.K., Zhang, W., & Jabbari, A. (2019, May) Single-cell profiling of cutaneous T-cell lymphoma reveals underlying heterogeneity associated with disease progression. Presented at the Society for Investigative Dermatology Annual Meeting in Chicago, IL.
- [19] **Borcherding, N.**, Bormann, N., Zhang, W. (2018, January). Using data analytics to predict and improve cancer immunotherapy response. Presented at the American Physician Scientist Association Midwest Regional Meeting in Iowa City, IA.
- [20] **Borcherding, N.**, Jo, S., Zhang, W. (2017, October). Targeting mismatch repair for basal-like breast cancer. Presented at the Cancer Biology Training Consortium Annual Meeting in Portland, OR.
- [21] Feagle, T., **Borcherding, N.**, Hoffmann, D. Students Prefer 3D Anatomy Videos for Prelab Preparation Compared to Traditional Resources and Usage is Related to Class Performance. Presented at the annual Experimental Biology Conference in Chicago, IL.
- [22] Kolb, R., Kluz, P., Wei, T.Z., Bormann, N., **Borcherding, N.**, Markan, K., Pothoff, B., Tan, N.S., Sutterwala, F., & Zhang W. (2017, February). IL-1 $\beta$  promotes obesity-driven breast cancer progression through the upregulation of Angptl4 in adipocytes. Presented at Inflammation-driven Cancer: Mechanisms to Therapy Keystone Symposia in Keystone, CO.
- [23] Schaefer, K.A., Toral, M., Velez, G., Cox, A., Baker, S., **Borcherding, N.**, Colgan, D.F., Smits, M.M., Bondada, V., Mashburn, C.B., Yu, C., Geddes, J., Tsang, S.H., Bassuk, A.G., Mahajan, V.B. (2016, June). Calpain-5 expression in the retina localizes to photoreceptor synapses. Presented at the FASEB Conference for The Biology of Calpains in Health and Disease in Big Sky, MT.
- [24] Kolb, R., Phan, L., **Borcherding, N.**, Liu, Y., Yuan, F., Janowski, A.M., Xie, Q., Markanm K., Li, W., Potthoff, M., Fuentes-Mattei, E., Ellies, L., Knudson, M., Lee, M., Yeung, S., Cassel, S., Sutterwala, F., & Zhang, W. (2016, January). Obesity-induced Nlr4 inflammasome promote

- angiogenesis in breast cancer. Presented at the AACR Special Conference: The Function of Tumor Microenvironment in Cancer in San Diego, CA.
- [25] Kolb, R., **Borcherding, N.**, Liu, Y., Yuan, F., Xie, Q., Sutterwala, F., Zhang, W. (2015, April). NLRC4 inflammasome promotes breast cancer progression in diet-induced obese mice. Presented at the American Association for Cancer Research Annual Meeting in Philadelphia, PA.
- [26] **Borcherding, N.**, Kusner, D., Kolb, R., Xie, Q., Zhang, W. (2015, April). Paracrine Wnt5a signaling inhibits the expansion of tumor initiating cells via Ryk/TGF $\beta$ R/Smad2. Presented at the ASCI/AAP/APSA Annual Joint Meeting in Chicago, IL.
- [27] **Borcherding, N.**, Kusner, D., Kolb, R., Xie, Q., Zhang, W. (2014, April). Wnt5a/ROR1 Axis in Triple Negative Breast Cancer Progression and Potential Therapy. Presented at the American Association for Cancer Research Annual Meeting in San Diego, CA.
- [28] Kolb, R., Liu, Y., Xie, Q., **Borcherding, N.**, Li, W., Zhang, W. (2014, April). Inflammasome activation in obesity-associated breast cancer progression. Presented at the American Association for Cancer Research Annual Meeting in San Diego, CA.
- [29] Xie, Q., **Borcherding, N.**, Kolb, R., Zhang, W. (2014, April). CD177, A novel Metastasis Suppressor of Breast Cancer. Presented at the American Association for Cancer Research Meeting, San Diego, CA.

## Academic Service

<b>2019-2020</b>	Alpha Omega Alpha Selection Committee, <i>Carver College of Medicine, University of Iowa</i>
<b>2016-2017</b>	LCME Accreditation Review Taskforce, <i>Carver College of Medicine, University of Iowa</i>
<b>2016-2017</b>	Medical Education Council, <i>Carver College of Medicine, University of Iowa</i>
<b>2016-2017</b>	First Aid/USMLE <sub>rx</sub> Student Council
<b>2015-2018</b>	Presidential Charter Committee for Recreational Services, <i>University of Iowa</i> Served as Chair 2017-2018
<b>2014-2018</b>	University of Iowa Research Council, <i>University of Iowa</i>
<b>2013-2016</b>	Graduate and Professional Student Government, <i>University of Iowa</i>
<b>2013-2014</b>	Graduate Student Senate, <i>Department of Pathology, University of Iowa</i>

## Selected Awards and Honors

<b>2023</b>	Emerging Generation Award, <i>The American Society for Clinical Investigation</i>
<b>2021</b>	Paul E. Strandjord Young Investigator Award, <i>Academy of Clinical and Laboratory Physicians and Scientists</i>
<b>2020</b>	Williams L. Roberts Young Investigator Award with Distinction, <i>Academy of Clinical and Laboratory Physicians and Scientists</i>

- 2020** Special Achievement in Pathology,  
*Iowa Pathology Society*
- 2020** Teaching Distinction  
*Carver College of Medicine, University of Iowa*
- 2019** Alpha Omega Alpha Honor Medical Society Induction  
*Carver College of Medicine, University of Iowa*
- 2018** Finalist, Graduate Research Excellence Award in Biological Sciences  
*University of Iowa*
- 2018** Hancher-Finkbine Medallion for Leadership, Learning and Loyalty  
*University of Iowa*
- 2018** Wilderness Medicine Race Winner  
*Carver College of Medicine, University of Iowa*
- 2017** Richard G. Lynch, MD Award for Pathology Research  
*Carver College of Medicine, University of Iowa*
- 2017** Research Award in Cancer  
*Carver College of Medicine, University of Iowa*
- 2017** Wilderness Medicine Race Winner,  
*Carver College of Medicine, University of Iowa*
- 2015** Member, ProQuest Hall of Scholars,
- 2015** Distinguished Thesis Award, Biological/Life Science,  
*Midwestern Association of Graduate Schools*
- 2015** L.B. Sims Outstanding Master's Thesis Award in Biological Sciences,  
*Graduate College, University of Iowa*
- 2015** Richard G. Lynch, MD Award for Pathology Research,  
*Carver College of Medicine, University of Iowa*
- 2014** Richard G. Lynch, MD Award for Pathology Research,  
*Carver College of Medicine, University of Iowa*
- 2013** Research Award in Cancer,  
*Carver College of Medicine, University of Iowa*
- 2012** Departmental Scholarly Achievement Award  
*Department of Food Science and Human Nutrition, Iowa State University*
- 2012** University Graduation Marshall  
*Iowa State University*
- 2012** Graduation Ceremony Student Address  
*Iowa State University*
- 2005** Eagle Scout  
*Boy Scouts of America*

## Military Experience

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### **Sergeant, Infantry**

May 2007 – May 2013

United States Marine Corps

- Served in Operation Iraqi Freedom II
- Served as Squad Leader and Fire Team Leader

### **Promotions**

<b>2012</b>	Sergeant
<b>2011</b>	Corporal
<b>2008</b>	Lance Corporal
<b>2007</b>	Private First Class